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Royal Entomological Society of London

CONVERSAZIONE

The attention of Fellows is drawn to the decision of the Council to hold a Conversazione after the Annual Meeting on 19th January, 1938. On this occasion the Conversazione will take the place of the delivery of a Presidential Address.

At the Annual Meeting the Report of the Council and the Treasurer's Report and Statement of Accounts for 1937 will be presented, after which the formal meeting will adjourn to the Library to inspect the exhibits there placed on view.

It is the earnest hope of the Council that Fellows will bring suitable exhibits to the conversazione, and table space will be available for the use of Fellows.

Whilst Fellows who require special arrangements to be made for the display of their exhibits are invited to communicate with the Registrar in advance of the meeting, the Council wish particularly to stress that small and informal exhibits will be welcomed, that exhibits by Fellows not ordinarily able to attend meetings will be especially appreciated, and that the conversazione will be informal in character. Evening dress will not be worn and guests of Fellows will be welcome to attend the meeting.

41, *Queen's Gate,*
London, S.W. 7.

December, 1937.

THE SPECIES OF DIPTERA CONCERNED IN CUTANEOUS MYIASIS OF SHEEP IN BRITAIN

By John MacLeod, D.Sc., Ph.D., F.R.E.S.

(*Cooper Technical Bureau, London.*)

Until the recent work of Haddow and Thomson (1937), it had generally been accepted that strike, or cutaneous myiasis of sheep, was due, so far as Britain is concerned, to only one species of fly, *Lucilia sericata* (Meig.).

In rare exceptions *Calliphora erythrocephala* (Meig.) and *Lucilia caesar* (L.) had also been recorded from sheep. Thus, Brown (1902) bred *L. caesar* from live sheep in the west of England, and Macdougall (1909) recorded, out of 51 infestations studied, three from which *C. erythrocephala* alone was bred out, and three where this species was present with *L. sericata*. He also cited Theobald as having bred *L. caesar* from sheep in Huntingdonshire and Kent, and stated that Theobald and Newstead both bred *C. erythrocephala* from larvae taken from live sheep. Maldwyn Davies (1934), out of 182 batches of larvae from sheep in Wales, obtained *L. sericata* alone in all but two batches, in which two *C. erythrocephala* was also present in small numbers. Similarly, Ratcliffe (1935), in Aberdeen, obtained only *L. sericata*, with one doubtful exception, where *C. erythrocephala* appeared, possibly as a contaminant of the laboratory culture.

In the light of this unanimity of evidence that *L. sericata* is, practically speaking, the sole striking species in Britain, the records of seven species of flies, bred from strike wounds by Haddow and Thomson, in 1933–35, are of extreme interest. These workers record, from strikes in south-west Scotland, the following species, in addition to *L. sericata* :—*L. caesar*, *L. illustris* (Meig.), *C. erythrocephala*, *C. vomitoria* (L.), *Phormia terrae-novae* (Rob.-Desv.), and *Muscina pabulorum* (Fall.).

They regard all the species other than *L. sericata* as secondary flies, and believe that they are, at present, of minor importance, but suggest that they are developing the parasitic habit. *L. caesar* was found to be numerically the most important of these " secondary " flies, occurring in 24 of the cases studied.

During the summers of 1934–36, I studied the species concerned in sheep strike in Perth, Argyll, the Lothians, and the home counties of England. The results obtained are in agreement with those of Haddow and Thomson, and are offered here as supporting evidence, in view of the absence of such records from the work of other investigators. In all cases, the larvae were obtained from live sheep. At the outset, a number of samples were found to have been contaminated with *Calliphora* spp. in the laboratory. These were discarded, and subsequently, to avoid the possibility of either adult flies or newly hatched larvae gaining access to the cultures, these were reared in closed containers, such as preserve jars, or cocoa tins with tightly fitting lids. Since, in the majority of instances, the larvae were partly or fully grown when obtained, contamination of such cultures would inevitably have betrayed itself, by the presence of young larvae. In many cases, no additional feeding was given, the larvae being placed directly into clean sand. In the case of the 1936 Argyll samples, small containers filled with a sand–sawdust mixture

were sent to the shepherds, who removed the larvae from strikes directly into these containers and forwarded them to the laboratory.

The breeding results are given below, and show that, in addition to *L. sericata*, flies of the *L. caesar* group (possibly including *L. illustris* individuals, for no attempt was made to separate this species, which is only distinguishable from *L. caesar* in the male), *C. erythrocephala*, *C. vomitoria*—in one doubtful instance—and *Phormia terrae-novae*,* were obtained from cases of strike. The probable rôle of each of these species is discussed later.

In 1934, samples of larvae obtained from 23 cases of strike on hill farms in Midlothian were successfully bred to adults. In 15 of these, *L. sericata* alone was present; the details of the remaining 8 cases are given in Table I.

In addition to these 23 samples, a mixed sample of larvae was taken by a shepherd from severe strikes in a blackface ewe and lamb. The larvae were left in a lump of soiled wool in an open pail for some hours before being collected by me. Both *L. sericata* and *Calliphora vomitoria* were bred out from this collection, but the possibility of contamination cannot be disregarded.

TABLE I.

Midlothian Cases. 1934.

Date.	Sheep.	Type of Strike.	Area Struck.	Flies Bred Out.
11.viii.34	B.F. ewe	Medium	Breech	*C. erythrocephala*
24.viii.34	B.F. lamb	Medium	Over kidneys	*C. erythrocephala*
30.viii.34	B.F. tup	Early	Base of horn	*L. sericata* and *L. caesar*
1.ix.34	B.F. lamb	Advanced	Flank and shoulder	*L. sericata* and *C. erythrocephala*
10.ix.34	B.F. tup	Medium	Breech	*L. caesar*
11.ix.34	Border Leicester ewe	Early	Foot affected with foot-rot	*L. caesar*
11.ix.34	Border Leicester ewe	Early	Foot affected with foot-rot	*L. sericata* and *L. caesar*
15.ix.34	B.F. ewe	Very advanced	Over greater part of body	*L. sericata* and *C. erythrocephala*

TABLE II.

South Perthshire. 1935.

Date.	Sheep.	Type of Strike.	Area Struck.	Flies Bred Out.
2.vii.35	Corriedale hogg	Medium	Over kidneys	*L. sericata* and *L. caesar*
2.vii.35	Lincoln ewe	Medium	Tail-head	*L. sericata* and *L. caesar*
5.vii.35	B.F. ewe	Advanced	Breech	*L. sericata* and *L. caesar*
12.vii.35	B.F. ewe	?	Larvae from a newly clipped fleece	*L. sericata* and *L. caesar*

* The synonymy of this species is in considerable confusion, and is at present under study. The name *Phormia terrae-novae* is used provisionally here, without prejudice to the ultimate decision as to the correct nomenclature of the species.

In 1935, out of 10 samples of larvae obtained from sheep in southern Perthshire, in the Aberfoyle district, four were found to be mixed infestations. (Table II.)

In 1936, by the courtesy of a number of landowners in western Scotland, samples of larvae taken from cases of strike were forwarded to me in England

TABLE III.

Argyll. 1936.

Farm.	Date.	Sheep.	Type of Strike.	Area Struck.	Flies Bred Out.
Farm A. Dalmally	2.vii.36	B.F. ewe	—	Soiled breech	*L. sericata* and *L. caesar*
	11.vii.36	B.F. ewe	—	Soiled breech	*L. sericata*
	13.vii.36	B.F. ewe	—	Soiled tail-head	*L. sericata*
	8.ix.36	B.F. tup	Early	Over kidneys	*L. sericata*
Farm B. Western Seaboard of Argyll	4.vii.36	B.F. lamb	—	Tail-head	*L. sericata*
	5.vii.36	B.F. ewe	—	Shoulder	*L. sericata*
	17.vii.36	B.F. lamb	—	Shoulder	*P. terrae-novae*
	21.vii.36	B.F. hogg	Restrike	Over kidneys	*L. sericata* and *L. caesar*
	16.viii.36	B.F. ewe	Restrike	Shoulder	*L. sericata*
	26.viii.36	B.F. tup	Early	Head	*L. sericata*
	26.viii.36	B.F. lamb	—	Tail-head	*L. sericata*
	2.ix.36	B.F. lamb	Early	—	*L. sericata*
	4.ix.36	B.F. ewe	—	Over kidneys	*L. sericata*
Farm C. Morvern	4.vii.36	B.F. ewe	—	—	*L. sericata* and *C. erythrocephala*
	7.vii.36	B.F. ewe	—	Soiled tail-head	*L. sericata*
Farm D. Morvern	1.vii.36	B.F. ewe	—	Soiled tail-head	*P. terrae-novae*
	1.vii.36	B.F. ewe	—	Clean wool, tail-head	*L. sericata* and *P. terrae-novae*
	4.vii.36	B.F. ewe	—	Throat	*L. sericata* and *P. terrae-novae*
	6.vii.36	B.F. ewe	—	Neck	*P. terrae-novae*
	31.viii.36	B.F. wedder	Early	Clean wool, tail-head	*L. sericata*
	31.viii.36	B.F. ewe	Early	Shoulder	*L. sericata*
	31.viii.36	B.F. ewe	Advanced	Over kidneys	*L. sericata*
	31.viii.36	B.F. ewe	Advanced	Over kidneys	*L. sericata*
Farm E. Mull	8.vii.36	B.F. ewe	Advanced	Tail-head and kidneys	*L. sericata* and *P. terrae-novae*
	25.vii.36	B.F. hogg	—	Over kidneys	*L. sericata*
Farm F. Mull	4.vii.36	B.F. ewe	Restrike	Shoulder	*L. sericata*
	4.vii.36	B.F. ewe	—	Shoulder	*P. terrae-novae*
	4.vii.36	B.F. ewe	—	Neck	*P. terrae-novae*
	6.vii.36	B.F. ewe	—	Neck and head	*P. terrae-novae*
	21.vii.36	B.F. lamb	—	Over kidneys	*L. sericata*
	25.vii.36	B.F. lamb	—	Shoulder	*P. terrae-novae*
	25.vii.36	B.F. tup	—	Soiled flank	*L. sericata*
	7.ix.36	B.F. lamb	—	Clean wool on back	*L. sericata* and *C. erythrocephala*
	9.ix.36	B.F. ewe	—	Flank	*L. sericata*
	9.ix.36	B.F. ewe	—	Shoulder	*L. caesar*

by the shepherds on six farms. Of these, 35 were successfully bred out and identified; in Table III the details of all of these cases are given, in order to illustrate the distribution of the mixed infestations.

On the 7th and 9th October, 1935, two samples of larvae were obtained from moderately old cases of strike in two Hampshire lambs in Hertfordshire. Of these, one was a pure colony of *L. sericata*, the other a mixed infestation of *L. sericata* and *L. caesar*.

In 1936, 51 samples were collected from struck sheep, in this area, between the 20th June and the 24th October. In seven instances a mixed infestation was present. The details and distribution of these seven cases are given in Table IV.

TABLE IV.

Herts. 1936.

Date.	Sheep.	Type of Strike.	Area Struck.	Flies Bred Out.
20.vi.36	Hampshire Cross Lamb	—	Foot infected with foot-rot	*L. sericata* and *L. caesar*
1.vii.36	Hampshire Lamb	Advanced	Breech	*L. sericata* and *L. caesar*
20.vii.36	Hampshire Lamb	Advanced	Abdomen	*L. sericata* and *L. caesar*
10.viii.36	Suffolk Cross Lamb	—	Foot infected with foot-rot	*L. sericata* and *L. caesar*
12.viii.36	Hampshire Lamb	Medium	Breech	*L. sericata* and *L. caesar*
12.ix.36	Hampshire Cross Lamb	Medium	Tail-head	*L. sericata* and *C. erythrocephala*
16.ix.36	Hampshire Cross Lamb	Advanced	Breech and rump	*L. sericata* and *L. caesar*

Analysis of results.

In some of the foregoing records the type of strike is stated, *i.e.* early, medium, or advanced. Little importance can be attached to this, however, for the severity or size of a strike is not a simple function of its age; the weather conditions during the intervening period, between initial oviposition and observation, is by far the most important factor affecting the rate of development and spread of the lesion, through its effect on fly activity, and thus on secondary oviposition.

The following analysis of the results indicates some points of interest. (*a*) Of 68 Scottish cases, 27 were wholly or partly due to species other than *L. sericata*, whilst only 8 out of 53 English cases were due to other than this species alone.

(*b*) *L. caesar* was found both alone and with *L. sericata* in foot-rot lesions. Two of the cases where *L. caesar* was alone present (Table I) appeared to be such recent infestations that it is probable that this species colonised the lesions. Apart from foot-rot cases, one clearly recent infestation by this species and *L. sericata* was found at the base of a horn; in all other instances the state of development of the lesions was such as to make it impossible to say whether the species was secondary or not in these instances. Excluding foot-rot cases, the species occurred in 5 out of 51 cases in England, and in 9 out of 66 cases in Scotland.

(*c*) *Calliphora erythrocephala* occurred altogether in 7 cases, 1 in England and 6 in Scotland. These were all medium old or advanced cases of strike.

(*d*) *Phormia terrae-novae* was recorded only from Argyllshire cases, and only in July.

Seasonal distribution of species.

There is no indication in the above records of a seasonal difference between the activities of *L. sericata* and those of the *L. caesar* group, although such might have been expected, from the differential response to environment demonstrated by Holdaway (1933). The records of Haddow and Thomson, also, show that *L. caesar* or *L. illustris* can occur at any time throughout the blowfly season. Similarly, *C. erythrocephala* has been recorded from cases of strike in July, August, and September.

With *Phormia terrae-novae*, however, the result is rather different. Although on three of the four farms from which this species was obtained collections of larvae were taken from sheep in July, August, and September, the species occurred only in the July samples. Similarly, the latest date at which the species is recorded by Haddow and Thomson is the first fortnight of July. There is a further indication, from the work of these authors, that this species is an early season striking fly. In their collections from Arran, they do not record the species, although they state that all the shepherds were familiar with the characteristic puparia in the wool. The collections they record from this area are, however, all in August and September.

The significance of the different species.

In Australia, where the blowfly problem has reached its greatest magnitude, three principal groups of striking flies are recognised, *viz.* primary, secondary, and tertiary. Primary flies are those which initiate strike on sheep; they may strike an area of unbroken skin, or an already existing lesion. Secondary flies do not initiate strike; they are attracted only to existing strikes, and their larvae live on and extend the lesions produced by primary flies. Tertiary flies occur only in very advanced cases of strike, and are relatively rare.

Primary species may, and frequently do, act as secondary flies, being attracted by the presence of the larvae of their own or other species, either primary or secondary. That is, every fly which acts in a secondary capacity is not a secondary fly, and so it is necessary, in order to define the secondary group, to postulate an essential inability to initiate strike on healthy skin. There are two possible explanations of the obligatory nature of a true secondary habit. Ratcliffe (1935) suggested that the temperature at the skin surface under the fleece is too high for survival of the eggs of *C. erythrocephala*, which he therefore declared to be a secondary species. Another possible explanation is that secondary larvae are unable by themselves to liquefy solid tissue and are thus dependent on the previous activity of primary larvae.

It is possible that these two limitations act together in determining the rôle of obligatory secondary species. Larvae which normally would be unable to live at the skin surface of a sheep in fleece would nevertheless be able to survive in the stained wool over an exuding wound, or on the surface of an open lesion from which the wool had dropped. It is also probable that, once cytolysis were started by the activity of primary larvae, the process would continue spontaneously, partly as a body reaction to the continued aggravation of the wound, and partly on account of the inevitable bacterial activity.

Lucilia caesar.

It is uncertain how much reliance can be placed on the early records of recovery of this species. Before the work of Richards (1926), Collin (1926), and Aubertin (1933), one of the principal specific characters used for separating it from *L. sericata* was the absence of the third pair of post-sutural acrostichal bristles. In a number of rearing experiments I found that, of the progeny of single individuals of *L. sericata*, one or two were usually found to show this character, as a variant from the three-pair arrangement characteristic of *L. sericata*.

It is generally accepted that *L. caesar* acts only as a secondary fly, and certainly there are no records of its having been observed ovipositing on healthy skin, or of its recovery in pure culture from an incipient strike. It has, however, been recovered in pure culture (Tables I and III) from medium old lesions on the shoulder and breech. It has also been recovered in pure culture from foot-rot lesions, but there the conditions are equivalent to those of an existing strike lesion.

According to the two criteria advanced above—inability to survive at the skin surface, and inability to liquefy tissue by itself—it is not an obligatory secondary species, for an active and typical strike was produced on the rump of a healthy Hampshire lamb in September, by placing eggs of this species next to the skin, according to the method described elsewhere (MacLeod, 1937).

Further, of the twenty-four cases reported by Haddow and Thomson, in which the species occurred, in one an egg cluster was laid beside an old healed lesion, *i.e.* on an area where there was no existing exudation, five were cases of strike in which the skin was still unbroken, *i.e.* relatively early strikes, and in two instances the skin surface was just beginning to break.

The suggestion is made here that the species is a true primary species, which, however, rarely acts in this capacity, not because it is unable to do so, but because its range of attracting odours is more limited than that of *L. sericata*, or possibly is seldom trespassed on by healthy sheep under normal conditions.

Calliphora erythrocephala.

Attempts to produce strike experimentally with this species have been unsuccessful, with one doubtful exception, where the larvae developed, and produced an exuding wound, but were confined to the cotton-wool plug over this lesion. All cases from which the species has been recorded, and of which a description is available, have been either medium-old or advanced. As already mentioned, Ratcliffe has given experimental evidence to suggest that it is physiologically unable to act as a primary fly, and it is probable that this species is a true obligatory secondary striker.

Calliphora vomitoria.

It is very doubtful if this is normally a sheep-striking species. Whereas *C. erythrocephala* has been recorded altogether in eighteen instances in this country, *C. vomitoria* has only been recorded thrice. Of the two records by Haddow and Thomson, one is of an egg cluster only, and the other instance was from a very advanced case. The third record, given in this paper, is of doubtful value, as the species may have been a contaminant.

It is possible that this species may act as a tertiary fly, and that it is rarely found because relatively few very advanced cases are available or have been studied.

Phormia terrae-novae.

This species was bred in pure culture from seven of the ten cases in which it appeared; in the remaining three it occurred along with *L. sericata*. Six of the seven pure infestations were body strikes, on the throat, neck, or shoulders; none was stated to be an advanced case. Of the seven cases of infestation by this species recorded by Haddow and Thomson, three were pure cultures.

Experimental strike with this species has been produced repeatedly on healthy clean-woolled sheep. It is my belief that this is a true primary species, commonly occurring, in the early part of the season, in the Islands and western Highlands of Scotland. Its apparently restricted distribution may be related to the exceptional wetness of the climate of this area.

Summary.

A study of the flies concerned in sheep strike has confirmed the finding of Haddow and Thomson that species other than *Lucilia sericata* may occasionally strike sheep.

These alternative species were found to occur frequently in Scotland (27 out of 68 cases), and they must therefore be regarded as important. They occur rather less frequently in England.

Three alternative species are recorded from Scotland, *L. caesar*, *Calliphora erythrocephala*, and *Phormia terrae-novae*; the first two of these were also obtained in England.

L. caesar was found to be a more commonly occurring species than *C. erythrocephala*. *P. terrae-novae* appears to be confined to western Scotland, and to occur only in the early part of the season.

Experimental and inferential evidence is given in support of the contention that *L. caesar* and *P. terrae-novae* belong to the category of primary striking flies, whilst *C. erythrocephala* is a true secondary striking fly. *C. vomitoria* is held to be, at most, a tertiary striking fly.

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Book Notice.

Insect Enemies of Books. By H. B. Weiss and R. H. Carruthers. 1937. New York. The New York Public Library. (Bull. N.Y. Public Libr. 1936.) pp. 63, 4 pls. Price $0.30.

This book is divided into two parts: The important insect enemies of books by H. B. Weiss, and insect enemies of books: an annotated bibliography to 1935 compiled by R. H. Carruthers and H. B. Weiss.

In the first part each of the several insect pests of books is described and information given for the protection of books from damage likely to be caused. The second, and larger, part is the annotated bibliography arranged under the following headings: Bibliography, Ancient and classical periods, To the end of the Seventeenth Century, Eighteenth Century, Nineteenth Century, and Twentieth Century. The work is completed by an index; 493 titles are listed in the bibliography, which is printed in double column.

Book Notice.

Out of my life and work. By Auguste Forel. Translated by B. Miall. 8vo. London. (Allen and Unwin, Ltd.) pp. 352, 8 pls. 16*s.* 0*d.*

Dr. A. Forel, an Honorary Fellow of the Society from 1894–1931, was a famous Swiss Myrmecologist whose name will always retain an honoured place in Entomology. Forel was, however, even better known in other walks of life, and in this book, his autobiography, it is these that are most fully dealt with. His work as an alienist is described in some detail, especially in relation to the intrigues attendant on many state appointments in Switzerland long ago. His life work for prohibition of intoxicating liquor and for his particular form of Socialism are described; throughout the book is evidence of his interest in ants and ant-life.

Of Entomology as a life-long work, however, there is little note, the detailed story of this side of a very remarkable man's life is still to come, since, with so full a life of so long a span—Forel was well over 80 when he died—any particular phase must take its place in the whole story.

AN ABERRATION OF *ASPHALIA DILUTA* FAB. (LEPID.)

By H. M. Edelsten, F.R.E.S.

The specimen exhibited at the Meeting on 3rd November, 1937, was taken at light in mid-Sussex on 31st August, 1937.

The usual greyish colour is strongly suffused with fuscous, even to the extent of producing a fuscous-black antemedial fascia. Near the base and at the end of the cell, just before the tornus there is some chocolate-coloured suffusion. The hind-wings have the distal two-thirds almost entirely suffused with fuscous.

A GYNANDROMORPHOUS SPECIMEN OF *PIERIS NAPI* (LEPID.)

By G. R. Baldock, F.R.E.S.

A specimen of *Pieris napi* was exhibited by me at the Meeting on 3rd November, 1937, in which the left fore-wing and both hind-wings were ♂ and the right fore-wing ♀.

BUFF-SPECKLED VARIETIES OF *AMPHIDASYS BETULARIA* (LEPID.)

By G. R. Baldock, F.R.E.S.

In 1889, *Entomologist* **22** : 162–163 is found an account of the breeding of this buff-coloured variety by J. Fielding in 1877, written by J. Thorpe. Nine of the specimens were exhibited at the meeting on 3rd November, 1937.

CRATAERINA PALLIDA LATR., A PARASITE OF THE SWIFT (DIPTERA)

By C. T. Gimingham, O.B.E., F.I.C., F.R.E.S.

More than twenty specimens of the Hippoboscid fly, *Crataerina pallida* Latr., were taken on a swift that fell heavily to the ground in an exhausted condition and incapable of flight in my garden at Harpenden on 7th June, 1934. This large number of these parasites infesting a single bird would seem to be unusual and the loss of blood due to their feeding may have led to its fall.

AN ADDITION TO THE RECORDED PREY OF *PHILONICUS ALBICEPS* MEIG. (DIPT.)

By I. H. H. Yarrow, F.R.E.S.

A female of this Asilid was taken with the dragonfly *Enallagma cyathigerum* Charp. (♂) on the 20th August, 1937, at Studland, Dorset. A second specimen was seen with a dragonfly, but eluded capture.

This record is interesting because in Dr. Hobby's paper on the prey of British Asilidae (1930, *Trans. ent. Soc. S. Eng.*, 6) there is only a single record of Odonata being taken as prey, the Asilid, *Neoitamus cyanurus* Loew taking *Agrion pulchellum* Lind., in Sweden.

Book Notice.

Melanismus Albinismus und Rufinismus. Ein Beitrag zum Problem der Entstehung und Bedeutung tierischer Färbungen. Von W. F. Reinig. 1937. Leipzig. (Georg Thieme Verlag) (Probleme der theoretischen und angewandten Genetik). pp. 122, 27 figs. Price Rmk. 5.20 (25% reduction to foreign buyers).

This book is devoted to the three allied subjects of Melanism, Albinism and Rufinism, to each of which a chapter is devoted.

The book is addressed to research worker, student and general reader alike, and especial emphasis is laid on the problem of extreme coloration, and not on individual specimens in which the phenomenon occurs.

The examples used to support the arguments advanced are taken from all classes of the animal kingdom, but the many good illustrations are all of Lepidoptera. The work is treated throughout from the genetic standpoint, and includes notice of experimental work carried out on the problems discussed.

Book Notice.

Recent Advances in Entomology. By A. D. Imms. Second Edition 1937. London (J. and A. Churchill). pp. x + 431, 94 figs. 15*s.* 0*d.*

This is the second edition of a book first published in 1930. It comprises fifteen chapters:—Some Aspects of Morphology; Metamorphosis; Palaeontology; Sense Organs and Reflex Behaviour; The Fundamental Aspect of Coloration; Some Aspects of Ecology; The Practical Application of Ecology; Parasitism; and Biological Control.

There is an Index to Authors and a General index which completes the book.

The second edition has been increased by 56 pages over the first edition, and 27 figures have been added and 18 deleted.

The results of entomological research in the last seven years have been incorporated and, where necessary, the conclusions reached have been modified. In some cases, however, it has been found unnecessary to revise the conclusions formerly reached, and these have been reprinted *in toto*.

ARGYNNIS CHARICLEA SCHN., AND *A. IMPROBA* BUTL. (LEPID.)

By L. G. Higgins, M.A., F.R.C.S., F.R.E.S.

Although *A. chariclea* was described from Scandinavia as long ago as 1794, it remained an almost legendary insect until the last few years, when it has been found in many localities in Finmark.

A. improba, originally described from Nova Zemlya, was discovered near the Altevand in western Lapland by Sparre-Schneider towards the end of the last century. Both insects are rare. They live in the high mountains, and *improba* has not been found in Lapland below the level of 3000 ft. At this altitude the climate is very severe and the ground is free from snow for about three months each summer.

The distribution of these butterflies is of interest. They occur not only in Nova Zemlya, but in North America, and *chariclea* is common in Greenland. They have been thought to provide evidence of the extension of the American fauna into northern Scandinavia. Within recent years both species have been discovered in various localities in northern Russia and Siberia. Their habitat is truly circumpolar, always north of the 68° of North latitude, and they may have entered Lapland from the east.

In the case of *improba*, the European distribution is confined to a strip of mountainous country extending northwards from the Torne Traske for about 80 miles, and separated by nearly one thousand miles from the next nearest colony in northern Russia. It is very unlikely to occur in the intervening country, as this is not mountainous.

This remarkably discontinuous distribution is difficult to explain, and suggests that this species may represent an ancient fauna established in Norway before the relatively recent periods of glaciation. Specimens of both species were taken in the summer of 1937 in Lapland.

Book Notice.

A Catalogue of the Macrolepidoptera of Ireland [with Supplement 31st December, 1936]. By C. Donovan. 1936. Cheltenham and London. (Printed for private circulation by E. J. Burrow & Co.) pp. 100 [+ 6].

The catalogue has been produced as the modern successor to that of Kane, now nearly 40 years old, and is the result of half a century's work by Lieut.-Col. Donovan. It commences with the Rhopalocera and concludes with the Geometrae.

Under each species is given an indication of its occurrence and distribution, the number of broods and information regarding varieties and aberrations with localities. Certain species recorded by Kane from Ireland on insufficient evidence are included and commented on. The book has a stiff cover, and is of a very convenient size for consultation and transport.

A DRAGONFLY WITH DIPTEROUS PREY

By L. Parmenter, F.R.E.S.

Pyrrhosoma nymphula Sulzer ♂ with *Dolichopus nobilus* Meigen ♀ as prey was taken at Horsey, Norfolk (17.vi.1937). Both insects are widely distributed in Great Britain. The family Dolichopodidae are not mentioned as prey of this or any other species of dragonfly by Dr. B. M. Hobby in "The Prey of British Dragonflies" in 1933, *Trans. ent. Soc. S. Eng.*, **8**.

A CANNIBAL ASILID

By L. Parmenter, F.R.E.S.

Dysmachus trigonus Meigen ♂ with ♀, and ♂ with ♀ as prey, were taken near Horsey, Norfolk, 23.vi.1937. This species was found on the sand between regularly planted marram on the top of the sandbank which joins the dunes near Horsey, Norfolk. The females outnumbered the males. I know of no previous record of cannibalism in this species, although the habit has been recorded for the following British Asilidae: *Neoitamus cyanurus* Lw., *Asilus crabroniformis* L., and *Philonicus albiceps* Mg.

Book Notice.

Ferskvandsfaunaen Biologisk belyst. Invertebrata by C. Wesenberg-Lund. 2 vols. 4to. København, Gyldendalske Boghandel. Pp. vi + [ii] + 837, 24 pls., 846 figs. [1937.]

These two volumes are published with the assistance of the Carlsberg Fund, and are complementary to the "Insektlivet i Ferske Vande," by the same author, published in 1915. For this reason no true insects are included in these volumes.

Volume 1 contains the introduction, an appreciation of O. F. Müller with a portrait, and a detailed account of the biology of the Sponges, Coelenterates, Worms and Bryozoa found in fresh water.

Volume 2 is concerned with the Crustacea, Arachnida and Mollusca.

Much of the original work described here has been published in articles in journals devoted to fresh-water biology, and to this is added a summary of present knowledge. In the course of producing the work Prof. Wesenberg-Lund has brought together a collection of some 25,000 authors' separates!

The systematic arrangement adopted is that of the "Handbuch der Zoologie," whilst the nomenclature used is, in the main, that of "Süsswasserfauna Deutschlands."

A select bibliography is given, arranged under Classes, and a subject and author index are included.

A COLLECTION OF LEPIDOPTERA TAKEN BETWEEN THE TOWER OF LONDON AND THE MONUMENT 1925–1937

By A. Welti, F.R.E.S.

The collection described below was exhibited at the Meeting of the Society on 3rd November, 1937.

It is a freak collection of common Lepidoptera discovered in this "built-up" area. The collection has been divided into three sections :—

Section 1. Migrants—just passing through the territory from south to north or east to west. This comprises the following insects :—

Pieris brassicae
Pieris rapae
Aglais urticae
Vanessa atalanta
Macroglossa stellatarum
Orgyia antiqua
Plusia gamma

Section 2. Residents—insects apparently established in the area as they have been taken several times over the period and in some instances the larvae have been found :—

Spilosoma menthastri
Triphaena pronuba
Barathra brassicae
Mamestra oleracea
Apamea basilinea
Xylophasia monoglypha
Phlogophora meticulosa
Lycia hirtaria
Camptogramma bilineata
Xanthorhoe fluctuata
Eupithecia pumilata

Section 3. Accidental, occasional strangers, of each of which only one has been taken :—

Smerinthus populi
Acronycta psi
Agrotis exclamationis
Mamestra trifolii
Hecatera serena
Apamea secalis
Naenia typica
Hydroecia micacea
Leucania comma
Acidalia marginepunctata

and 2 undetermined small brown and black Noctuidae.

Book Notice.

The Dragonflies of the British Isles. By Cynthia Longfield. pp. 220, 38 pls. (col.), text illust. London (Warne & Co., Ltd.), 1937. Price 7*s.* 6*d.*

This book is uniform in size with the well-known entomological books issued by Messrs. Warne, and contains a descriptive history of all the British species of Odonata.

The book commences with a glossary, followed by a list of Latin and Greek names showing their usual pronunciation, a chapter on the life history of a dragonfly, on methods of collecting and preserving dragonflies, a calendar of the usual times of first appearance of species on the wing, a key to the identification of species, a series of illustrations of the wings and bodies of British species, and descriptions of our native species. A chapter on classification, a check list and an index in which synonyms are shown in parenthesis completes the book.

A notable feature of this work is the illustration of each species by a life-size half-tone photograph, and the similar illustrations of many of the nymphs.

Book Notice.

Strange Insects and their Stories. By H. H. Verrill. pp. xv + 205, 6 pls. (col.), 100 figs. London (Harrap & Co., Ltd.), 1937.

This book tells in popular language some of the interesting facts concerning insects. The contents, as stated on the title page, include—"How they live—Various kinds and species—Curious traits—Their intelligence—Ways of communicating with each other—Battle for survival—Benefit to all mankind, etc., etc."

A protest may be registered against the printing of the explanation of the coloured frontispiece on the flimsy paper inserted to protect the plate until the colours are dry.

Book Notice.

Ecological Animal Geography. An authorised, rewritten edition based on Tiergeographie auf oekologischer Grundlage by R. Hesse, prepared by W. C. Allee and K. P. Schmidt. pp. xv + 597, 135 figs. 8vo. New York & London (John Wiley and Chapman & Hall, Ltd.), 1937. Price £1 10*s.*

This book is an authorised translation of a famous book by Prof. Hesse published in 1924, but it has been completely rewritten, brought up to date, and to it have been added certain chapters on subjects more especially the study of the revising editors. Certain material which was not in accord with the revising editors' views has been deleted from the translation and in part replaced by other material.

Some modifications have been made in the references to animals. In some instances of animals referred to by name in the original German edition, substitution by American animals has taken place, and similar minor adjustments have been made.

In its present form the book comprises 28 chapters and an index, the chapters being arranged under the following headings:—The ecological foundations of zoogeography, the distribution of marine animals, the distribution of animals in inland waters, a phase in limnology, and the distribution of land animals.

To each of the chapters is appended a list of the works referred to in the chapter.

THE MIGRATIONS OF DAY-FLYING MOTHS OF THE GENUS *URANIA* IN TROPICAL AMERICA

By C. B. Williams, Sc.D., F.R.E.S.

(*Chief Entomologist, Rothamsted Experimental Station, Harpenden, England.*)

In a previous publication (Williams, 1930) I gave an account of what was then known of the movements of the two day-flying moths *Urania fulgens* Walk. and *U. leilus* Linn. in tropical America.

These moths are brightly coloured in dark brown, green and white, and have tails on the hind-wings. As a result they are frequently mistaken for butterflies of the genus *Papilio*. *U. leilus* differs from *U. fulgens* in being a little larger and with more white on the hind-wing, particularly on the tail. Records of their migrations are frequently received, and there is also some evidence that the related *Urania rhipheus* in East Africa also migrates.

Briefly summarised, the information available in my previous account showed that *Urania leilus* had been recorded migrating in Barbados, Trinidad, British Guiana and Brazil. In the three former countries the flights were all between July and October. In Brazil the only two flights in which the month was known were in January. About twenty-one records were available. *Urania fulgens*, on the other hand, had been recorded as migrating in Mexico, Nicaragua, Costa Rica, Panama, Colombia and Ecuador, the flights covering the period from the end of February to the beginning of September, with the majority during June, July and August. About twenty records were available for study.

In the last eight years a number of new records have come to hand, and it seems desirable to reconsider the evidence and to see to what extent previous conclusions are upheld or extended.

Urania leilus.

(1) As long ago as 1784, " A. H.", in the *Gentleman's Magazine*, wrote, " At Barbados, some days previous to the hurricane of 1780, the trees and shrubs were entirely covered with butterflies of the most beautiful colours, so as to screen from sight the branches and even the trunks of the trees. In the afternoon before the gale came on, and when it was quite still, they all suddenly disappeared."

It is impossible after this lapse of time to do more than guess at the species, but to my knowledge the only brightly coloured " butterfly " that has been noted in recent years to turn up suddenly in Barbados in large numbers and to attract popular attention is *U. leilus*, so that it is quite likely that this early record refers to the same moth.

I am informed by Mr. C. J. P. Cave, of the Royal Meteorological Society, that the hurricane referred to was on the 10th October, 1780.

(2) Dr. G. R. Walker informed me that during two years residence at Tajapuru and Breves Channels, between the Amazon and the Para River, Brazil, he saw flights of *U. leilus* on many occasions. They were always approximately to the south-east, and usually during the rains, which in that district are from January to June. The prevailing wind (" the trades ") was from the south-east, but the weather was often calm.

(3) Mr. A. V. Stewart observed a flight of *U. leilus* at Carapito, Venezuela, at the end of April and the beginning of May, 1937. The direction of movement was towards the north-east. The flight was definite for about eight days, but after that thinned out a great deal, but still maintained its direction. The insects were flying low, not over eight feet from the ground. During the main flight about four insects were visible at one time throughout the day.

By the 8th June there were still a few passing, but the direction was not definite.

Mr. Stewart sent me one specimen which was *Urania leilus*.

(4) The Rev. Miles Moss told me that in Para and up the Amazons scattered specimens of *U. leilus* are seen flying across the Amazon from north-west to south-east at many, but not at all times of the year. Unfortunately no exact dates are available.

(5) Mr. E. N. Willmen observed a small flight of *U. leilus* in a southerly direction in British Guiana near the junction of the Mazaruni and Essequibo Rivers on 23rd April, 1933.

These five records do not greatly increase our knowledge of the movements of this species. There had been no previous record from Venezuela, so that the range is extended a little in this direction. It is unfortunate that the records from Brazil, although both refer to a number of flights observed, should be so indefinite as to dates.

Urania fulgens.

(1) *Mexico.* Mr. O. G. von Turckheim wrote to me that *U. fulgens* was migrating at Tapachula, Chiaspas, Mexico, from 26th to 30th April, 1937. Tapachula is in the extreme south of Mexico, about ten miles from the Guatemala border and about 3200 ft. above sea-level. The moths were flying from north-west to south-east, always one to three in sight, usually fluttering along, one to one hundred feet above the ground. The flight continued usually towards evening, but not after dark. The wind was light, mostly south-west. On 1st May there was a storm, and the flight ceased. A similar flight had been seen about two years previously, but the date not noted.

Between 1st to 3rd June, 1937, another flight took place in the same direction as the previous flight. At mid-day about sixty moths per minute were passing on a twenty five-metre front; in the evening only about fifteen. Their speed was fifty metres in fifteen seconds (7·8 m.p.h.). Height above the ground, one to one hundred feet, mostly about fifty feet.

Mr. Turckheim sent me one specimen, which was *U. fulgens*.

(2) *Guatemala.* Mr. M. Y. Fuentes reports a big swarm of *U. fulgens* migrating at San Marcos towards the end of June, 1937. San Marcos is in the extreme west of Guatemala near the Pacific coast and the Mexican border. He says the moths, of which two specimens were sent to me, were flying from Mexico by various routes to El Tumbador, about 1000 metres above sea-level. It would appear from this that the flight must have been more or less to the east, south-east or south. The swarm was about 500 metres broad and 10 km. long, and was flying " very high " in the air.

(3) *Honduras.* Mr. J. Deal informed me that he witnessed a migration at Tela, Honduras, between 12th to 16th December, 1935. Thousands of butterflies and day-flying moths of at least six different kinds in which, however, *U. fulgens* predominated, were flying towards the east for at least five days. By the 16th they had thinned out to stragglers. They were flying about fifteen feet

high, above the roofs of the bungalows; the wind was inland from the north and rather cool. The other species included white PIERIDAE. No specimens were captured.

Mr. P. R. Gleason at San Juancito, Honduras, saw a migration of *U. fulgens*, unaccompanied by any other species, during August, 1937, flying towards the south-east. They were seen on nearly every fair day. On 1st August all appeared to be females, and were flying east by south against an east wind of perhaps 10 m.p.h. from 4 to 6 p.m., all above ten feet from the ground and up to fifty feet. About 300 were seen per hour within ordinary range of vision. After that date males, which were smaller and more difficult to catch, were included. The females sometimes broke rank when pursued by a male, but no pairing was seen. The flight continued to a less extent in early September, but by 26th September not a single specimen had been seen anywhere for several days.

Mr. Gleason questioned a number of residents, and although several had noticed flights to the south-east, none had seen a return in the opposite direction. All observers agreed that the moth completely disappears for months at a time.

(4) *Costa Rica.* Wallace (Williams, 1933) recorded occasional specimens all flying to the north and with apparent purpose at Cartago, Costa Rica, in April and May, 1928. They were flying three to ten feet above the ground. On 20th May they were also seen flying in the same direction near Rio Cimarrones, east of Sicuizzes.

F. A. Vedoua wrote that near San José, Costa Rica, this moth migrates every year from south to north between March and May and from north to south in August. The size of the swarm varies in different years. In 1927 there were very large swarms in March and April, when the flight lasted continually for five to six weeks, but he does not recollect whether the August flight was equally large that year or not. About four years ago (writing 1937, hence about 1933) there was just as large a migration to the north in March and April and towards the south in August. For several weeks the entire area was practically filled with butterflies; there must have been millions. Friends reported similar movements on the Atlantic coast, and swarms were seen in the mountains at 2000 metres. Only low cloud and fog made them diverge from their course, and he saw them come flying back when the weather became clear, and continue their normal direction.

They fly sometimes low, and sometimes up to thirty to forty metres. During good weather the flight lasts all day, and in spring they fly against the steady and storm-like north-east wind. In August the weather is usually calm.

In March and April of 1937 he saw only very few. In August of 1937 there was no evidence of a return flight, and Mr. Vedoua considers that this was due to the comparatively dry weather of the preceding months.

(5) *Panama.* Mr. H. W. Kierstead noticed a migration of *U. fulgens* in Las Cacados, Canal Zone, Panama, one day in the second half of 1909. They began to pass over about noon and continued until towards sunset, all flying towards the north-east. They were again seen in smaller numbers on the following day. The flight was at least half-a-mile wide, and the height of flight from a few feet above the ground to a little above the roofs of the bungalows. The insects kept to their definite direction and cleared obstacles by vertical movement, and not by diverting to the side. The flight was rapid and strong, and large numbers were constantly in view.

In 1924 F. R. Smith observed a movement at Almirante, Panama, from 26th August to 4th September towards the north. On the 26th August they were flying rapidly and singly or in twos and threes. The main body took four days to pass. In general, they kept low above the grass, and were never seen to alight.

In 1926 towards the end of September Mr. P. R. Gleason saw a large flight over the sea off the Pacific coast of Panama. When first noted his boat was about twenty miles off shore and about 200 miles from Balboa (by its own route). The moths were coming in from the sea and flying towards the land against the usual off-shore breeze, which was quite light. The number increased all day, and at night thousands came to the ship's lights and became a regular pest on board. Next morning the ship (making about eleven knots) arrived at Balboa, and the moths were then flying in a direction slightly south of east, following the general trend of the isthmus and making for some point on the west coast of Colombia. They were noted until 4 p.m.; by sundown there were very few, and next morning none. The speed of flight was not more than 6 m.p.h. and most were fifteen to twenty feet up. In Panama they were quartering across a light north or north-east off-shore breeze. The flight must have contained several million insects. Weather fine, day bright and nearly cloudless.

A flight of *U. fulgens* in 1931 from July to September was recorded by Zager. (1932) from west to east in various localities in Panama, including David, Chirique Province, and also at Panama City, 400 miles to the east. The insects first appeared on the 15th July, increased to a maximum about the 15th August, and then decreased to about the 15th September. On the 20th September none could be seen. They were flying both near to the ground and high up like specks in the sky.

On the 1st August of the same year Tilette (Williams, 1933) saw from a steamer in the Canal large numbers of *U. fulgens* flying to the north-east. They were noted throughout the whole passage, but were most abundant about 3 p.m. in the neighbourhood of the Culebra Cut. He estimated that about 200 were crossing the steamer (about 480 feet long) at one moment. The breeze was gentle south-west.

From 28th-31st August, 1936, J. Deal saw at Guabito, Panama, a flight of thousands passing towards the north-east from the hills to the lowlands. What little wind there was was from the sea, *i.e.*, from the north. Flights were seen on several other occasions, always in the same direction, but the dates were not noted.

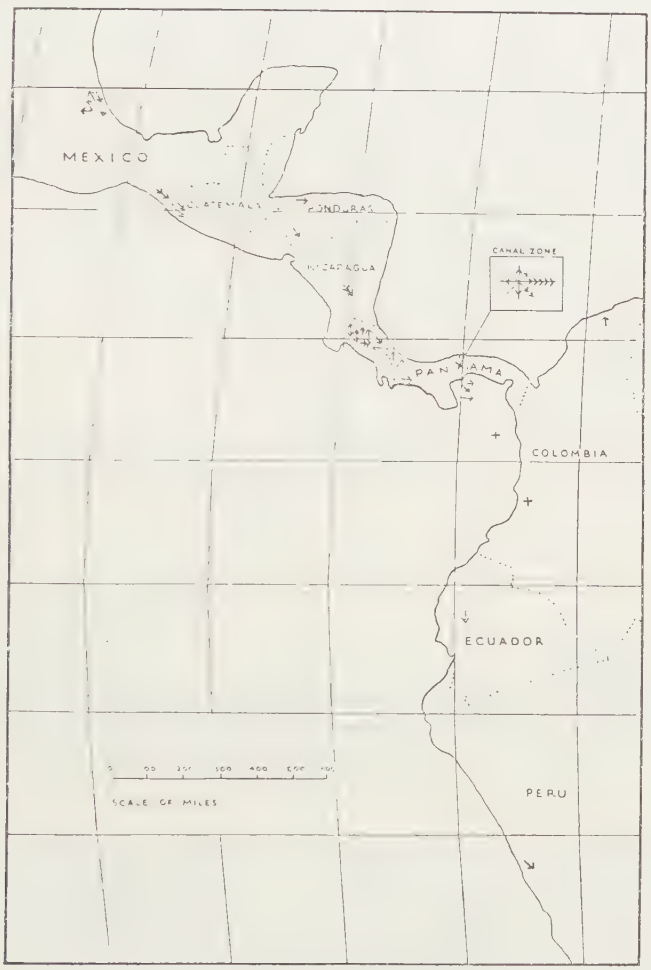
About the 10th December, 1936, Dr. C. E. Palm noted large numbers migrating over Colon, Canal Zone. Thousands were seen over the bay in the morning, but the direction of the flight was not recorded.

In January, 1937, Mr. P. F. Eckstorm observed numbers at sea between Panama City and Buenaventura on the west coast of Colombia. One came on board about three miles off shore at Buenaventura and stayed on board till the coast was reached.

(6) *Colombia* (see also previous record). In 1895 Mr. W. F. H. Rosenberg (Williams, 1935), when at Los Cisnerios in Colombia, was suddenly surrounded by enormous numbers of *U. fulgens*. They were first noted on the 12th of May and lasted for three days, and by the 16th not one was to be seen. No record of the direction was kept. According to Mr. Rosenberg, Los Cisnerios (formerly Los Mangos or Juntas) is a village on the road from Buenaventura to Cali in western Colombia, at an altitude of about 1000 ft., at the junction

of the Rio Dagua and Rio Pepita. It is a humid tropical zone with dense forests.

(7) *Peru.* According to the Rev. Miles Moss, many worn specimens of *U. fulgens* were seen in 1908 at Lima, Peru, passing to the south-east towards the Andes. They stopped to sip at flowers and also visited street lamps. No record was kept of the exact date.

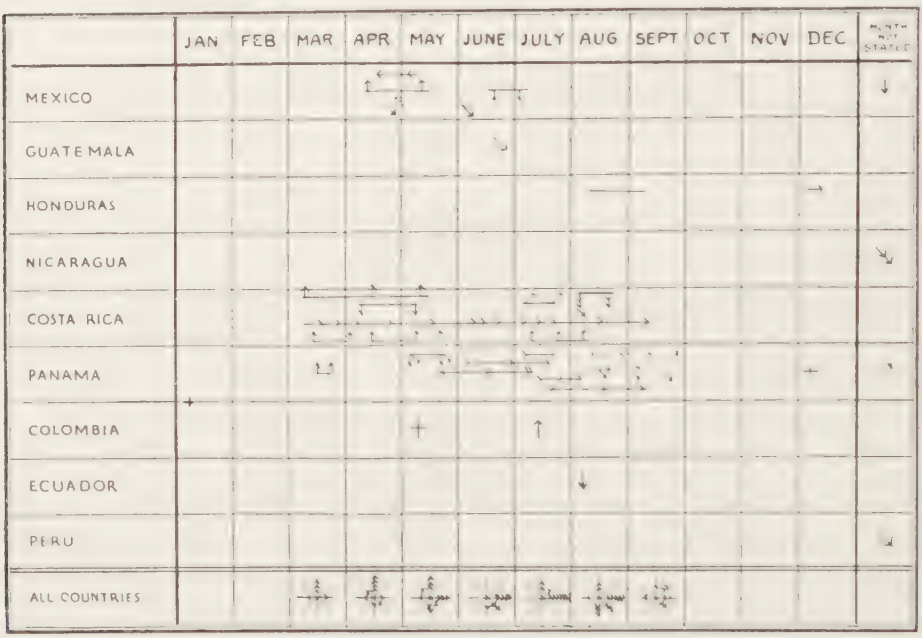


1

The map (fig. 1) shows all the localities from which *U. fulgens* has now been recorded as migrating and also the direction of the flights. The distance between the most northerly and the most southerly recorded flights is over 2500 miles. The frequency of records in the Canal Zone in Panama is undoubtedly only due to the much greater number of visitors with entomological interests.

Fig. 2 shows diagrammatically the dates and directions of the recorded flights arranged according to countries from north to south. At the bottom of this figure is a summary of records for each month.

In the first place I might point out that in Panama there appears to be a very regular movement towards the east. There is, in fact, only one record in the opposite direction. This is from a note in *Nature* (1873), which states that, according to the *Star* newspaper, the "annual flight" was proceeding towards the *west*. The implication is that the flight was of regular occurrence, and unless one is to suppose that the direction of flight has altered, the weight of a large number of more recent records makes it likely that this westerly direction is an error.



2

The problem of the reversal of flight is still very confused. In 1857 Friedrich (van Bemmelen, 1857) gave a very detailed account of a regular reversal taking place in south-east Mexico. He stated that the insect (wrongly identified as *U. leilus*) migrates every year in the State of Vera Cruz, beginning in April for two or three weeks. The moths follow the eastern slopes of the Cordilleras from Anahuac, somewhat more to the east than the direction of Orizaba or Ciltaltepetl, towards Coffre de Perote or Neucampatepetl, and away northwards, always at the foot of the hills. They return along the same route from north to south five or six weeks later, but in reduced numbers, the survivors greatly exhausted and the females without eggs.

In Costa Rica the evidence of different collectors seems to be directly opposed. C. H. Lancaster wrote to me in 1928 from near Cartago that *U. fulgens* "in some years passes for weeks in countless numbers, roughly from north to south and then what may be called 'echo' migrations occur in the reverse direction: the first in the early months and the latter in June, July or August."

Mr. F. A. Vedoua, writing in 1937 from a locality about 6 km. west of San José, said, " Every year it migrates from south towards the north in March to May, and from the north towards the south in August, but the size of the swarms differs greatly from year to year." He has noted this phenomenon for many years.

Finally, Gillot (1924) says that every year in central Costa Rica the species migrates from west to east against the wind from February to September, with maxima in February–March and June–July. There is no reversal of flight direction.

Thus there are three statements, one that they move to the south about April and the north about July; one that they move to the north about April and the south about July; and one that both the main flights are in the same direction, towards the *east*. Authorities are, however, in agreement as to the occurrence of two main flight periods.

Taking all the evidence as summarised in the lower part of fig. 2, it would appear probable that there is a movement more or less northerly in March and April, and a movement more or less to the east or south-east in June to September, but how the conflicting opinions for the one relatively small area can be reconciled is not easy to see. Only more and more records can show the true state of affairs.

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Book Notices.

Charles Darwin. The Fragmentary Man. By G. West. 1937. London (G. Routledge). pp. xiii + 351, 8 pls. 15*s.* 0*d.*

This is the first full-length biography of Charles Darwin by an English author since the appearance of Francis Darwin's *Life and Letters* in 1887. The passage of this half-century has made it possible to write an appreciative account not immediately affected by the nearness of publication of Darwin's works.

The book is divided into four parts: Family Overture, concerned with Darwin's ancestors in the Darwin and Wedgwood families; The Making of the Man, treating of youth, education and the "Beagle" voyage; The Man Making; and Commentary. A Bibliography is appended, divided into three sections, each arranged under a different system.

The treatment is essentially biographical in the later sense of that term, and the book would appear to be addressed to the general reader perhaps more than to the scientist.

It should be pointed out that the Rev. F. W. Hope was not "first Professor of Zoology at Oxford," as stated on p. 71.

Fragments of entomological history, including some personal recollections of men and events. By H. Osborn. 1937. Columbus, Ohio. Published by the author. Pp. 394, 47 pls.

The contents of this book are as stated in the title and, as is to be expected, it is concerned essentially with American Entomology in its wider sense.

It has twelve chapters, entitled Early Steps in Entomology, The nineteenth century, Federal Service in Entomology, State entomologists, inspectors and quarantine officers, Experiment Station entomology, Entomological instruction in Colleges, Entomological Societies, Entomological Publications, Personal sketches, Insect collections, Some regional notes and Miscellaneous notes. An index covering nine pages in three columns completes the work.

As stated in the title, the book is largely written from personal information, which is so very difficult to obtain except from books such as this. A large part of the book is devoted to personal sketches of hundreds of entomologists who have been or are at work on American insects, and in the majority of cases a portrait is given, there being between 300 and 400 photographs of entomologists on the 47 plates.

DEFAECATION BY A JASSID SPECIES

By H. H. Storey and R. F. W. Nichols.

(*East African Agricultural Research Station, Amani, East Africa.*)

Communicated by Dr. V. B. Wigglesworth, F.R.E.S.

With Plate 1.

While studying the behaviour of *Cicadulina mbila* Naude, the vector of a virus affecting maize, we have made observations on its methods of defaecation that appear worthy of record.

The usual process of defaecation is unremarkable. The insect raises the tip of its abdomen, the nymph generally more so than the adult; and the anal cone, which has slowly partly advanced from its normally retracted position, is suddenly protruded to its full extent. A spherical droplet of a clear fluid appears and rests momentarily on the anus (fig. 1) and is then projected, without any visible movement of the abdomen, a distance horizontally sometimes as great as twice the insect's length (fig. 2). About three droplets an hour is the usual rate of emission by an insect resting with its mouth-parts inserted into a maize leaf; but sometimes this is greatly exceeded, one insect having been observed to produce 80 droplets in 58 minutes, and during a part of this time a droplet every half minute.

This clear fluid may no doubt be regarded as the "honey-dew," well known for many groups of the Homoptera. It appears, however, not to be generally appreciated that plant-sucking insects may have a second and distinct form of defaecation. (We find no mention of it in Weber's recent works (1–4).) In the Jassids it may have been overlooked owing to the curious method of faeces-disposal that we now describe.

This second method of defaecation by *Cicadulina mbila* takes the following course in the adult insect. The abdomen is raised and its tip curved downwards (fig. 3), and from the anus there flow two or three drops of a viscid opaque yellowish fluid (fig. 4). The drops are received in succession on to the tibia of a hind-leg, each held in readiness alternately, and transferred at once to the anterior edge of the forewing (fig. 5). By slow movements of the leg the drop is spread somewhat on the upper surface of the wing (fig. 6). The insect now rests; and in drying the drop of faeces passes momentarily through a whitish shining stage when apparently a dry surface film has formed, and finally remains as a smooth dry mass of dull yellowish material (fig. 7). Thereupon the insect begins violent cleaning movements with its legs, which may continue for two to fifteen minutes, until all but a trace of the faeces have been scraped away and thrown off as a powder (fig. 8).

In the nymph the procedure is somewhat different. A preliminary movement is the withdrawal of the fore-legs, one at a time, from their normal forward position, and their disposing in a backward direction alongside the two other pairs of legs. Thereupon the insect raises its body to an angle of about 50–60° to the leaf surface, balancing itself on its rostrum and frons alone (figs. 9 and 10). The tip of the abdomen momentarily curves over, and a single drop of opaque fluid is delivered on to the tarsi of the hind pair of legs (fig. 9). The drop is now held away from the body (fig. 10), and by slow "kneading" movements, in which all the legs take part, is distributed and adheres to the legs. The insect may rest for a few seconds; but usually movements of the legs continue

until the faeces dry and fall away as a powder. Only then does the insect resume its normal position parallel to the leaf-surface.

The insect defaecates infrequently in this way, and twice in one day is the maximum number of times we have observed. Nevertheless we have watched the process more than fifty times in adults and ten times in nymphs, and always the course has been as described. A slight stain on the fore-wing may commonly be observed on any adult *Cicadulina mbila*.

Our observations do not provide clear evidence concerning the mechanism by which the droplets of honey-dew are projected. Since the droplet rests momentarily on the anus, it cannot be due to internal muscular contraction of the rectum. Whatever the mechanism may be, however, it appears to depend upon the high surface tension of the droplet, which causes it to take a spherical form (fig. 1). The cloudy faeces, which flow from the anus, are evidently of lower surface tension, and observation suggests that they could not be similarly projected. But equally the method actually adopted is effective because the low surface tension permits the drop to adhere to the wing or tarsi.

On the generally accepted hypothesis, the defaecation of honey-dew is a process for the rapid elimination primarily of surplus water extracted by way of the filter-chamber from the dilute food solution taken from the leaf. We suggest that in the cloudy faeces are eliminated the products excreted through the Malpighian tubules.

References.

1. Weber, H., 1930, *Biologie der Hemipteren*. Berlin, 543 pp.
2. ——, 1929, *Biologie der Tiere Deutschlands*, Hemiptera, **1** (29), T. 31 : 1–70.
3. ——, 1931, *idem*, Hemiptera, **2** (34), T. 31 : 71–208.
4. ——, 1935, *idem*, Hemiptera, **3** (38), T. 31 : 209–355.

Explanation of Plate 1.

Fig. 1. The termination of the abdomen, in silhouette, with a droplet of honey-dew on the anus.

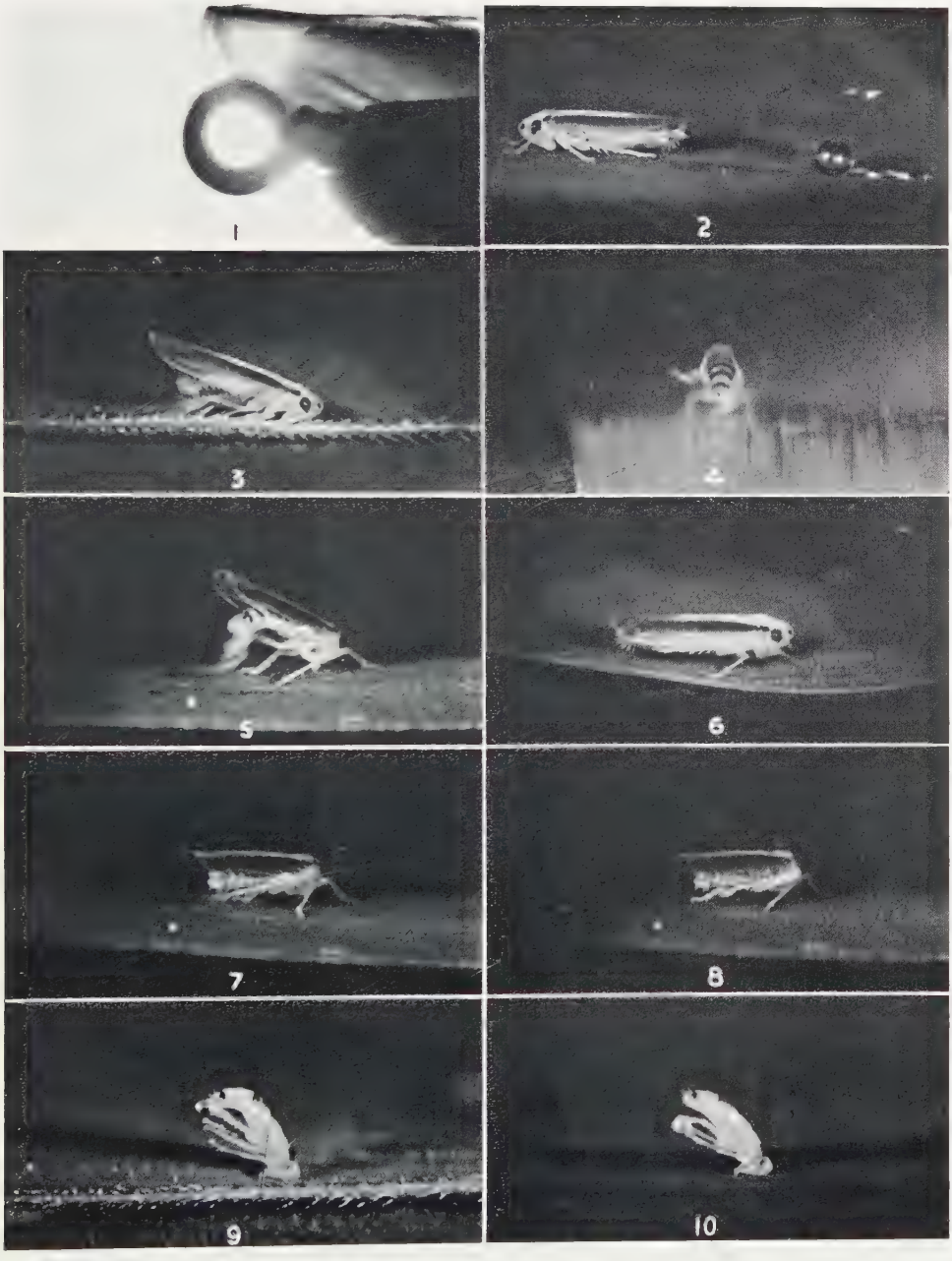
2. An insect defaecating honey-dew at about one droplet every 30 seconds. A droplet is visible in the original photograph on the anus. The large drop on the leaf is the accumulation of many droplets projected from the anus.

The defaecation of opaque faeces by the adult.

3. Abdomen raised; tip of abdomen turned down. Hind legs moving below abdomen to receive faeces.
4. End view, showing abdominal tip turned down and drop of faeces hanging from anus. Legs moving to receive faeces.
5. One drop of faeces transferred by leg to right forewing. Second drop being received by left leg (blurred by movement).
6. Drop of faeces being spread on forward edge of wing by hind leg.
7. Insect beginning to remove dried faeces by scraping with legs.
8. The same insect as fig. 7, at conclusion of cleaning, showing all but a trace of the faeces removed.

The defaecation of opaque faeces by the nymph.

9. Body raised and insect resting on its rostrum and frons alone. Drop of faeces issuing from anus.
10. Faeces received on to tarsi of legs and being spread by "kneading" movements.



ENGRAVED BY STAR ILLUSTRATION, LONDON.

The defaecation of "Honey Dew," by *Cicadulina mbila*. Fig. 1, x 84; figs. 2-10, x 7.

THE CONSTITUTION OF NECTAR SECRETED BY THE EXTRA-FLORAL GLANDS OF COTTON—A NATURAL FOOD OF THE BOLLWORM MOTH, *HELIOTHIS ARMIGERA* HUBN.*

By F. S. Parsons, B.Sc.Agr., F.R.E.S.

The relation of food requirements and feeding habits of the cotton bollworm moth, *Heliothis armigera* to mating, longevity and fecundity have recently been examined. Food and sex responses have a special interest in studies of the perception, by olfactory or other means, of the food-plant.

According to various investigators supported by my own observations, the moth requires carbohydrates and can convert to monosaccharides the sucrose which is fed commonly in varying solutions to insectary material. In nature, however, *H. armigera* imbibes freely the sugary secretions of the nectaries of cotton and other plants, the constitution of which, it appears, is not known specifically, and the analysis presented below was undertaken primarily with a view to composing a natural food.

Haberlandt (1914), in describing the nectar-secreting system of plants and mode of exudation, states that nectar always contains a large amount of sugar and, after Bonnier, that gum, dextrin, mannite and certain compounds of phosphorus and nitrogen may also be present in small quantities, the water content varying between 60 and 85 per cent. According to Nenyukov (1927), nectar, source and proportions unspecified, is composed of sucrose, glucose and fructose, a small quantity of mineral and aromatic substances, dextrins, resins and tannin. The same author quotes Kustenmacher in stating that traces of oxalic, malic and tartaric acids may be present, also insignificant quantities of phosphates and albumen, the last being accidental additions from pollen. Wilson (1878) has reported the amount of sugar per flower in the nectar of various flowers, and it may be assumed from his data that there are very wide differences between species in the quantity of total sugars in the nectar, allowing for evaporation, visits of insects and inaccessibility. Vansell (1934), in drawing attention to the quality of nectar irrespective of quantity, supplies additional evidence of the variation in the average sugar content, in these instances between the secretions of the blossoms of several species of fruit tree, and he notes that the visitation of bees occurs when the sugar concentration becomes increased by evaporation of the water during the periods of low humidity.

As Quaintance and Brues have mentioned previously (1905), the sugar solutions, generally of sucrose, used for feeding *H. armigera* in the laboratory must be given sparingly, otherwise the moths gorge themselves and fermentation of the undigested sugar causes premature death. In view of this and the reported variations in the sugar content of nectar, together with the possible value of other components, it was decided to determine the composition of a natural food of the insect as a prelude to further observations on food requirements and feeding habits. The analysis of cotton nectar is given here.

* Contribution from the Cotton Insect Pest Control Section of the Cotton Experiment Station, Barberton, South Africa.

The foliar and extra-floral nectar-secreting glands of cotton.

The foliar glands are situated on the midrib of the under surface of leaves. The glands are conspicuous, but the quantity of nectar produced, mainly at night-time, is relatively very small: the secretion at these sites was not analysed, as *Heliothis* moths do not appear to visit them according both to local observations and to earlier ones of Quaintance and Brues (*loc. cit.*) in America.

Two sets of extra-floral glands may be present in cotton, viz.: (A), three placed on the apex of the peduncle embraced by the base of the bracteoles; and (B), three additional glands placed on the base of the calyx-tube, within and alternate with the bracteoles; these are all more or less circular glands that secrete a large amount of sweet fluid. The outer lot, (A), are present from the commencement of flowering: they begin to secrete visible quantities of nectar as the bud is about to unfold to the open flower. The inner lot, (B), is stated to appear and function after the plant has been blooming about one month, but these glands may be present or absent in different species of cotton. Watt (1907): they were not observed on the U.4 strains of cotton grown at Barberton, and the nectar examined was collected from the three glands of the (A) set on U.4 material. As the oviposition by *Heliothis armigera* is synchronous with the flowering curve of cotton, Parsons and Ullyett (1934), the moths inhabit the crop during the period in which nectar is most abundant.

Methods and determinations.

Freshly-opened flowers and buds about to unfurl were collected with their bracteoles to the number of some 20,000. The collections were made in the evenings and early mornings in order that the water content of the nectar would be the same as that obtaining when the moth attends the flowers. Immediately after each collection specimens with visible beads of liquid at the bracteole glands were selected and the liquid was taken up in capillary tubes and stored under toluene at a temperature of 35° F. Many of the glands were not secreting available nectar, and the total accumulated was 10 c.c.

Qualitative determinations.

Inorganic constituents.

A 2-c.c. portion was utilised. After determining the water content to be 66 per cent., the organic matter was removed by treatment with aqua regia and subsequent evaporation three times with hydrochloric acid. The remaining slight solid was taken up in the smallest quantity of dilute hydrochloric acid and subjected to the usual tests. In several of these and in the organic tests a piece of apparatus made from the design of Carlier and Lovat (1910), consisting of a length of capillary tubing in which are blown two small bulbs about one and a half centimetres apart was used. A very small quantity of fluid may be aspirated into the bulbs followed by the reagent: mixing occurs in the lower bulb, and the result may be viewed in the capillary against a suitable background or under magnification.

The only inorganic constituents detected were potassium and sodium present as chlorides, which were determined on a separate sample. Probably some acid potassium oxalate existing as the acidity of the fluid (see below) was attributed to oxalic acid. The amounts indicated of these components were too slight for quantitative determination.

Reaction. The nectar solution was weakly acid. A faint precipitate of calcium oxalate was obtained in testing a dilution of 1 c.c. of the solution for the nature of the acidity and a somewhat larger precipitate of lead oxalate was determined also in subsequent tests for other compounds. As free oxalic acid is found very rarely in plants, the reaction was due probably to an acid oxalate.

Organic constituents.

The tests were made on samples drawn from a further 2 c.c. of the solution.

Protein.—Negative results were given for the Xanthroproteic, Millon's and the biuret reactions, and it was concluded that proteins were absent. Accidental inclusions in noticeable quantity from pollen grains are most unlikely, as the bracteole glands are outside of the corolla and protected by it from falling pollen.

Tannin, Gum and Resin.

These were not represented according to a number of the usual tests. A precipitate obtained on the addition of normal and basic lead acetates was identified as lead oxalate.

Dextrins.

Amylo- and erythro-dextrin were not present by colour reaction with the iodine reagent and achroo or unchanged dextrin was not indicated in the 90 per cent. alcohol test. The possibility of the presence of maltose was borne in mind in later treatment with phenylhydrazine, but the osazone of maltose did not appear.

Pentoses.

The reactions with phloroglucinol and aniline hydrochloride were negative for pentose, but indicated fructose.

Monosaccharides.

The presence of reducing sugars was evidenced by Folin and McEllroy's and Fehling's tests. Of these, glucose was identified by the method of saccharic acid formation and crystallisation as potassium hydrogen saccharate. The colour reactions in the pentose tests and on applying Pinoff's method with alcohol–sulphuric acid and alpha-naphthol indicated fructose, but not specifically, as the latter reacts to a disaccharide yielding a ketose on hydrolysis. Identification of fructose was obtained, however, in the crystallisation of the methylphenylosazone and determination of the melting point at 152° C.

Disaccharides.

A separate sample of 1 c.c. of the nectar solution was used. After removal of the reducing sugars the presence of a disaccharide was determined after hydrolysis with hydrochloric acid.

Reactions of the sugars with Phenylhydrazine.

A faint white crystalline precipitate appeared within one minute after heating. The presence of mannose in cotton nectar is therefore indicated, but the quantity of osazone formed was relatively very slight. Within a few

minutes an orange-yellow precipitate of heavy proportions came down. There being no pentose present in the solution, it was apparent that hexosazones had been formed. No further precipitation occurred within thirty minutes while the solution was still hot or upon cooling, thus osazones of disaccharides were not formed. As sucrose does not form an osazone, the disaccharide present was taken to be sucrose.

Sufficient osazone material was supplied from the 2 c.c. of nectar solution utilised for these reactions to obtain purification on recrystallisation. After purification the melting point of the hexosazones was observed as 208° C., which is correct for the osazones of glucose and fructose.

Quantitative determinations.

The quantities of reducing sugars present before and after inversion of sucrose were determined gravimetrically under the conditions prescribed by Munson and Walker and given by Morrow (1927): the remaining 2 c.c. of nectar solution being used for the purpose. The results were: reducing sugars as glucose 32 per cent. and the rather surprisingly low sucrose content of 1·36 per cent.

The constitution of the nectar may be given then as follows:—

	Per cent.
Reducing sugars, glucose and fructose (mannose present in minute quantity)	32·00
Sucrose	1·36
Water	66·00
Potassium and sodium as chlorides and probably some acid potassium oxalate	trace

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Book Notice.

Die Blatt-Minen Mittel-und Nord-Europas einschliesslich Englands. Lief. 5. 1937. By M. Hering. Neubrandenburg: G. Feller Verlag. Pp. 449–560, pl. 7, text illust. Subscription price Rmk. 12.00 per Lieferung.

This part of Dr. Hering's work comprises the genera *Rubus* to *Zinnia*, and leaves only the sixth Lieferung with the indices to complete the work.

A fuller description of the scope of the work will be found in 1936, *Proc. R. ent. Soc. Lond.* (B) **5**: 226.

A NOTE ON *PLATYCLEIS GRISEA* (F.) (TETTIG.), DEVOURING *ZYGAENA FILIPENDULAE* AT SENNEN, CORNWALL

By C. H. Andrewes, M.D., F.R.E.S.

The female Tettigoniid, determined by Dr. R. Hanitsch, was exhibited by Sir Edward Poulton, who said that his friend had written from Sennen, near Land's End, on 22 August, 1937 : " Yesterday I saw a big brown grasshopper happily chewing a *Zygaena filipendulae*. Of course I don't know if it had killed it or not. The uneaten parts looked in good condition." Dr. Andrewes explained later that the insects were on the ground, on a low, rocky, heathery cliff by the sea at Aire Point, about 2 miles N.E. of Land's End and that only a small part of the Zygaenid had been eaten. It was uncertain whether the prey had been captured alive or found dead, but its condition suggested the former. The speaker had not before heard of an attack on a Zygaenid by one of the voracious, insect-eating Tettigoniidae.

Book Notices.

Termite City. By A. E. Emerson and E. Fish. 8vo. New York, etc. Rand, McNally & Co. $1.50. pp. 127, 37 figs. [1937.]

This book is an account of the life in a termitarium, by Prof. Emerson of the University of Chicago, written especially for boys and girls.

The six chapters are concerned with the rôle of the soldier caste, the ancestry of termites, the departure of winged females from the termitarium, the rôle of termitophiles, some special points of individual behaviour, results of termite attack on buildings and furniture, a glossary of terms and an index.

The species of termites described is not stated, but the book deals entirely with species found in British Guiana. In the Glossary are included terms relating to termites from other localities, in order that children or beginners wishing to continue their reading may understand essential technical terms.

Man and the termite. By H. Noyes. 1937. London. Peter Davies. Price 8*s.* 6*d.* Pp. xiv + 289, 8 pls.

This book is written in non-technical language by a tropical agronomist who has had long experience of termites under nature in many countries.

It is concerned with *Termes natalensis* chiefly, but the habits of other species are described to illustrate special features of their domestic economy.

Chapters are devoted to special aspects of the communal life of termites and of their guests and parasites. The progress of an individual is described from the hatching of an egg to maturity.

The habits of termites from selected parts of the globe are described, as are their depredations and benefactions to man. The bibliography, unfortunately, has many misprints.

Book Notices.

The Zoology of the Faroes, edited by A. S. Jensen, W. Lundbeck, T. Mortensen and R. Spärck. Copenhagen. A. F. Høst & Søn. (Published at the expense of the Carlsberg-Fond.) Vol. 2, Part 1. Crustacea, Myriopoda, Insecta 1. Price 15*s*. 0*d*.

The Zoology of the Faroes will be published in three volumes, each of two parts, and the part here noticed is the first to appear. The complete work will cost £4 10*s*., and parts will not be sold separately.

Volume 2, Part 1, comprises ten articles on Crustacea, one on Myriopoda and nine on Insects. Each article is paged separately, the articles being numbered consecutively, the insects commencing with article XXXIII.

Each article gives a short historical statement showing previous records from the Faroes, and this is followed by a systematically arranged list giving a reference to a published figure where possible, and in all cases a reference to a standard work. A few new subspecies and aberrations are described and figured, and in many cases comparative tables showing distribution in the Shetlands, Faroes and Iceland are given.

Entomologie. Mit besonderer Berücksichtigung der Biologie, Ökologie und Gradationslehre der Insekten. By W. Speyer. Dresden and Leipzig. T. Steinkopff. (Wissenschaftliche Forschungsberichte Naturwissenschaftliche Reihe, Band 43), pp. xi + 194. Price (paper covers) Rmk. 13.00, (bound) Rmk. 14.50.

This book sets out to give a conspectus of the published results of entomological work since 1914. The author estimates that 2500 authors publish 3500 works on ecological, biological and systematic entomology in 2000–2500 journals annually. These works are written in some 50 languages in 15 different alphabets.

The nine divisions of the book are: 1. Palaeontology and Phylogeny, 2. Morphology, Anatomy and Physiology, 3. Life-cycle, 4. Parasitism and Symbiosis, 5. Reaction to specific conditions, 6. The influence of biotic and abiotic factors on various phases of insect life, 7. Migration, 8. Economic importance of insects, 9. Literature.

Where the author was unable to refer to original sources, reference is made to text-books and published summaries. In all other cases the original sources have been used.

LIZARDS AS ENEMIES OF BUTTERFLIES

By Prof. G. D. Hale Carpenter, D.M.

(*Hope Professor of Zoology (Entomology) in the University of Oxford.*)

With Plates 1–2.

Examination of butterflies for evidence of attacks by birds has resulted in the discovery of several hundreds of examples of beak-marks on the wings. Among these may be mentioned that described by Poulton [1] as "remarkable and characteristic" and now shown at Pl. 1, fig. 1. The suggestion of Mr. Rait-Smith, who captured the butterfly, that the mark might be the work of a bird *or* lizard is shown to be correct, for the outline of the mouth of a Slow-worm figured by Collenette [2] corresponds well with the marks on the wings.

It seems probable that the mark on the left fore-wing of the *Danaus plexippus* from Ternate (Pl. 1, fig. 4), in spite of the narrowness of the lines and absence of marks of teeth, was produced by a lizard: at any rate it proved impossible for Dr. Percy Lowe, then curator of birds at the British Museum (Natural History), to find any bird's beak to fit it. This specimen was discovered in the collections at Oxford in 1933. Since then, although constantly finding beak-marks among collections, I have only been able to get together eight other butterflies with the broadly rounded marks suggesting the mouth of a lizard, some of which are also figured here. Besides these specimens Mr. C. L. Collenette has kindly shown me a specimen of the Notodontid moth *Lophopteryx angulata* Gaede from the Ivory Coast in the national collection, with beautiful imprints showing marks of the teeth of a lizard. The point which I now stress is the great rarity of marks which can be attributed to the wide mouth of a lizard, as compared with the not uncommon beak-marks with acutely angled apex. Mr. L. Richmond Wheeler, M.Sc., in response to a query, kindly wrote from Penang, 14th August, 1937, "I have occasionally found good lizard marks on butterflies' wings, with small teeth indications inside the jaw outline. They are, however, rare." I am not here referring to *injuries*, or gaps in the wings caused by the breaking away of a piece of tissue. It is, I think, generally accepted that lizards commonly eat butterflies. Cedric Dover [3] wrote, "That birds do eat butterflies is an established fact, as I have repeatedly seen them doing so . . . in my opinion the worst enemies of butterflies among the Vertebrates are the Lacertilia," and gave as examples *Calotes* and *Varanus*. "The tree snakes probably feed to a large extent on the smaller Rhopalocera . . . on a small island in the Chilka lake which I visited . . . I twice saw *Dendrelaphis tristis* attacking and eating specimens of *Colotis calais amatus* and *Huphina nerissa evagete*. . . ."

The difficulty of obtaining evidence on these points is very interesting. Thus I have just received a letter from Lt.-Col. H. D. Peile, I.M.S., a collector of many years' experience in India, in which he says, "I have never seen a lizard capture a butterfly." Substitute the word "bird" for "lizard" and this is what F. C. Selous said for Africa; evidence of which much has been made by those who deny that birds are the selective agents causing mimicry in butterflies! On the other hand, Lt.-Col. Peile cites several cases of birds which he saw catching butterflies.

Cockayne made some remarks upon the part played by lizards as enemies of butterflies.[4]

If lizards do eat butterflies to an extent at all comparable with birds, why do they so seldom leave imprints on the wings? Are they less particular than birds, which, having seized a wing, lose the butterfly in an endeavour to shift the grip on to the body? If lizards do not object to wings and devour the whole, they cannot exercise so strong a selective action as birds which seem deliberately to release "distasteful" butterflies[5] with little damage. (But see later.) The very many cases of beak-marks on the wings of such relatively inedible insects as Euploeines, Danaines, Ithomiines, Acraeines, Heliconines, suggest that the insects escape, perhaps owing to the more flexible quality of their wings, or are released when the bird has experienced the strong odour, or fluid, produced by rough handling.

It seems probable, from such evidence as I have already collected, that beak-marks are more often found in these "inedible" species. Apart from the real meaning of this fact, it may be pointed out that this disposes of one of the suggestions that has been made, that birds catch butterflies for fun, and not for food. Do they, then, practise chiefly on those which they can distinguish as aposematic and therefore distasteful? The argument might, of course, be extended to say, "Yes, they do, because, as the theory of warning colours demands, they are the most easily caught." But, on the other hand, if birds want "fun" or practice, it would surely be better to try to catch the more difficult fliers!

The divergence of opinion on these matters is quite entertaining. L. R. Wheeler[6] states that the evidence suggests that birds, when they *do* attack butterflies, do so when the latter are at rest with wings closed. That the premisses on which this conclusion is based are faulty has been shown by the me.[7] But Lt.-Col. Peile (and others) think that the discrepancy at issue may be due to the fact that "the lizard goes for the butterfly when at rest and at short range, so that there is rarely a chance of the butterfly being able to escape to show a mark, whereas probably most beak-marks are made when both the bird and its quarry are on the wing when the chance of capture is far less certain than in the case of the lizard." The greater prevalence of beak-marks on aposematic species, however, suggests that this does not really explain matters, for it would suggest, on this interpretation, that birds attack distasteful species more than edible ones.

This question, whether birds or lizards are the agents through which selection works, was raised by Marshall[8] and Poulton[9] with the conclusion that mimicry being less abundant in localities particularly favourable to lizards these probably were less effective agents than birds. It must, however, be pointed out that in considering mimicry as predominantly a question of forest habitat, the activities of tree-frequenting lizards high up in the canopy were not included. There are, I believe, no truly arboreal lizards in the forests of Africa where mimicry is so common.

It cannot be doubted that lizards have some powers of discrimination between insects of various appearances and tastes, and references are given to some published facts bearing on this point.[10, 11, 12, 13, 14, 15] Are they quicker than birds to distinguish at sight, so that they less often capture specimens which are subsequently disliked and released? This does not seem likely.

Another possible explanation of the discrepancy is that lizards' teeth are more apt to sever the tissue of the wings than a bird's beak, and that instead of making an imprint upon the scales, the jaws bite out a piece, so that a broad

gap is produced such as may often be seen in captured butterflies. These must not, however, be considered as necessarily the work of lizards, for many of the butterflies which were given to birds experimentally by Swynnerton, and were rejected after rough treatment, show much the same injuries. Broad gaps in the margins of the wings, therefore, may have been caused by either bird or lizard, but the outline of the jaw of each is unmistakable when imprinted on the scales of the wing.

List of Specimens Collected, Showing Imprint of Lizards' Mouths.

Palaearctic.

1. *Maniola jurtina* L. Plate 1.
2. *Vanessa atalanta.*
   Captured at Friston near Eastbourne by Miss C. M. Jannings, 10.x.1937. The left fore-wing bears a rounded mark, obviously that of a large lizard, possibly caused by a Green Lizard in the south of France or the Channel Isles.

Ethiopian.

3. *Papilio dardanus* Brown, ♀ form *dionysos* Dbl. & Hew. Plate 1.

Oriental.

4. *Danaus plexippus* L. Plate 2.
5. *Euploea kinbergi* Wallengr. Hong Kong. Fruhstorfer collection.
   A typically rounded lizard's mark, showing imprints of teeth at the base, is directed backwards along the edge of the left hind-wing in areas 4 and 3.
6. *Euploea kinbergi* Wallengr. Hainan. Fruhstorfer collection.
   A slightly asymmetrical, but obtusely angled, mark is shown on both fore-wings, entering the outer (hind) margin at its middle and directed inwards. A small portion is missing from the anterior part of the margin of each hind-wing. Probably the butterfly was seized at rest.
7. *Euploea nemertes polymela* Godm. Santa Cruz, Solomon Islands.
   An extremely typical imprint on the outer (hind) margin of the right fore-wing, directed forwards, and another on the hind margin of the left fore-wing, directed inwards to anal angle.
8. *Tenaris urania* L. Amboina. Swinhoe collection.
   A very clear mark extends into the base of area 2 from the middle of the costa of the right fore-wing.

Neotropical Region.

9. *Tithorea hippothous* G. & S. Plate 1.
10. *Ceratinia nina chapadensis* Talb. Brazil, Matto Grosso, Burity, 30 miles north-east of Cuyaba, 2250 feet, 1–14.vii.1927, C. L. Collenette.
    The mark of a very small lizard is shown at the tornus of each front wing, directed forwards.

Reviewing these ten cases, it is seen that three specimens (1, 6, 10) were seized when the wings were together, the remainder by one wing.

Specimen no. 7, a typical aposematic insect, was seized again after having once being seized and released: a significant fact, for it was not eaten. It is interesting that, of the eight tropical species, six are typically aposematic. There is certainly reason for thinking that *Tenaris* may be distasteful, and also *Papilio dardanus*.

Thus the evidence suggests that lizards, like birds, release distasteful species.

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Plate 1.

Fig. 1. *Maniola jurtina* L. ♀. Scotland, Kincardineshire, Muchalls, 3.vii.1936. W. Rait-Smith. The markings on all four wings show that the insect was seized from in front in the position of complete repose.

2. *Euploea nemertes polymela* Godm. ♂. Solomon Isles, Santa Cruz, October 1898. Two separate attacks have made marks on the right fore-wing and left hind-wing.

3. *Tithorea hippothous* Godm. & Salv. ♀. Trinidad, Port of Spain, 9.i.1913. K. St. A. Rogers. The mark, on the angle of the left hind-wing is faint and is reproduced in the line drawing.

PHOTOS BY IMPERIAL FORESTRY INSTITUTE, OXFORD. ENGRAVED BY STAR ILLUSTRATION, LONDON.

Imprints of lizards' jaws on wings of butterflies.

1

2

PHOTOS BY IMPERIAL FORESTRY INSTITUTE, OXFORD. ENGRAVED BY STAR ILLUSTRATION, LONDON.

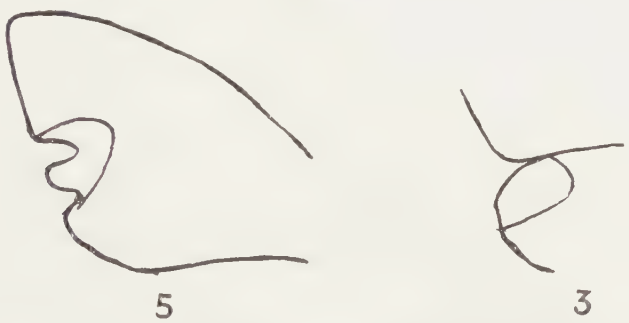
Imprints of lizards' jaws on wings of butterflies.

PLATE 2.

Fig. 1. *Danaus plexippus*. ♂. Moluccas, Ternate, 22.xi.1891. J. J. Walker. The mark extends from the end of vein 1 on the left fore-wing to the root of vein 3, the whole of the left-hand limb of the loop is not visible in the photograph.

2. *Papilio dardanus* Brown, ♀ f. *dionysos* Dbl. & Hew. The base of the mark is indicated on the left fore-wing by two notches : the mark runs inwards and forwards from the margin to vein 5. It is reproduced in the line drawing.

All specimens in the Hope Dept. of Entomology, University Museum, Oxford.



OBSERVATIONS BY MR. R. E. MOREAU ON A NESTING AFRICAN SHRIKE CAPTURING BUTTERFLIES

By PROF. G. D. HALE CARPENTER, F.R.E.S.

MR. R. E. MOREAU, of the East African Agricultural Research Station at Amani, Usambara, Tanganyika Territory, kindly sent the following notes, which are printed *in extenso* as received.

" Yesterday in Acacia-desert-grass community at Mkomasi (about 100 miles from here) Mrs. Moreau found a nest of *Eurocephalus rüppellii* (White-headed Shrike) with two young nearly ready to fly. After watching for the parents for some time, we saw one near the nest pulling a butterfly to pieces. On the spot, under what was evidently a favourite perch, we found a litter of wings. Our attention now being aroused, we soon realised that butterfly wings were scattered about over a wide area around the nest. Most of them were to leeward (the south-east monsoon had been blowing fairly steadily for some weeks), and in that direction were traceable for 150 yards from the nest. We had no difficulty in spotting the wings on the almost bare ground, and undoubtedly scores of individuals were represented, including I think, from the enclosed specimens, about six species.

" This is the solitary instance within our experience where any bird was taking butterflies as an important item of its diet. There was no dearth of other food. Grasshoppers were about in immense numbers, and were being utilised by several other species of birds. (Mr. E. Burtt, who was with us, caught over thirty species of LOCUSTIDAE in a few acres.) Butterflies were in their usual abundance at this season, just after the end of the rains; fairly comparable, I should say, in numbers with those over a spring meadow in England.

"As the parent shrikes would not go to the nest while we remained in sight of it I cannot say whether the butterflies were being fed to the young or not. Most probably, though not certainly, the butterflies were caught on the ground, not on the wing: *Eurocephalus* is a very clumsy bird, and during the prolonged dry season when hardly any butterflies are about, I have often seen it dropping from an elevated perch on to ground insects."

The species noted by Mr. Moreau were as follows: identification was by the fragments sent, none of which show clear beak-marks.

Glycestha creona severina Stoll. (*Belenois severina*). ♂, L.F.W. 2, R.F.W. 1 (in detail closely similar to one of the L.F.W.), L.H.W. 1, R.H.W. 3 (1 in detail closely similar to one L.H.W.).

Glycestha aurota Fab. (*Belenois mesentina* Cramer). ♂, R.F.W. 2; ♀, L.F.W. 1, base of R.F.W. 1, L.H.W. a fragment, R.H.W. a fragment.

Colotis (*Teracolus*) *halimede acaste* Klug. ♂, L.F.W. 2, R.H.W. 1.

Colotis auxo incretus Btlr. ♀, L.F.W. 1, L.H.W. 1, R.H.W. 1.

These species were mentioned as "common on the wing, and their remains were by far the commonest in the litter."

Glycestha creona severina. ♀, L.H.W. 1, fragment of R.H.W. 1.

Colotis evagore Klug. ♂, R.F.W. 1.

Reported as "not numerous on the wing, and the fragments sent were the only ones we saw in the litter."

Danaus chrysippus L. f. *dorippus* Klug. ♂, outer half of R.F.W. This, "quite common in life, was represented in the litter by only this one wing. But in quite another place we found three more detached wings of this species. There was nothing to show whether the owner might have been killed by a bird."

A specimen of *severina* and one of *Herpaenia eriphia* Godt. were also sent "only in case they may assist in identification." There were, however, no portions of *eriphia* among the specimens sent from the litter. Examples of *Precis oenone cebrene* Trim., and *P. cloelia* Cr. were sent, and Mr. Moreau wrote that these, "and a bigger black and yellow thing which evaded us, were the only fairly common butterflies on the wing that we did not find in the litter." The identity of the uncaptured species can only be surmised; it may have been *Colotis protomedia* Klug, often common.

It is of some interest that the Shrike seems to have captured insects of much the same size, with the exception of the single smaller *evagore* and the larger *dorippus*. Mr. Moreau, so well known as an ornithologist, is less familiar with insects, and it is possible that the smaller and less noticeable Satyrinae and Lycaenidae, which usually abound in such terrain as is indicated by the species sent, eluded his notice. Species of *Colotis* generally form an important part of the fauna in these localities, but appear not to have been so at the time of this observation.

The two common species of *Precis* seem not to have been eaten; they do not, however, attain the abundance of *Glycestha* and the same can be said of *dorippus*. Mr. Moreau's interesting observation suggests that the most plentiful butterflies were taken: it would have immensely increased the value of the record if a comprehensive collection of all the wings and fragments could have been sent.

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